EDITORIAL ARTICLES.

ON THE CAUSE OF DEATH AFTER BURNS.

THE various theories of the cause of death following burns have lately been enriched by that proposed by Welti,[1] who regards thrombosis in the brain, stomach, and kidneys produced by the heating and swelling together of the blood-disks, and the alteration in the vessels caused by this thrombosis, some of the vessels being constricted while others are dilated.

This theory is also supported by Silbermann,[2] who, however, ascribes the greatest influence to the alteration in the blood-corpuscles, and who also says that the thrombi are most numerous in the pulmonary vessels and lead to emptying of the right heart.

Salvioli[3] has studied this subject anew, and finds that the blood-disks do form white thrombi in the burned area and that their conveyance to distant parts produces emboli. There is also well-marked narrowing of the arteries and a change in the red corpuscles, which become pasty. When dogs are subjected to repeated bleeding until their blood has become very poor in corpuscles, it is found that they will bear very large and severe burns without fatal results, for the reason that the formation of thrombi and emboli does not occur.

Kijanizyn[4] found in the blood, internal organs, and urine of patients a toxic substance which was best obtained by Brieger's methods. This ptomaine was an amorphous body of yellowish or yellowish-brown color and of a penetrating, offensive odor, soluble in water and alcohol, slightly so in chloroform and benzine, and insoluble in ether. Moderate solutions injected subcutaneously produced in animals apathy, somnolence, diarrhœa (at times bloody), vomiting, and reduction of the temperature. The author declares the severe symptoms following a burn of great extent to be due to this poison and also to the affected condition of the kidneys, and other parenchymatous organs through the formation in them of thrombi and the subsequent degeneration.

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[1] Ziegler and Nauwerk's Beiträge, Band IV.

[2] Virchow's Archiv, Band CXIX, Heft 3.

[3] Virchow's Archiv, Band CXXV, Heft 2; Monatsh. für prak. Derm., Band XVI, No. 6.

[4] Wratsch, 1891, No. 16; Monatsh. für prak. Derm., Band XVI, No. 16.

Lustgarten[1] considered that the fatal result was produced by a ptomaine developed in the necrosed coagula and absorbed into the system, and points to the fact that deep burns with charring of the tissues are relatively less apt to be fatal than incomplete burns, for the reason that putrefaction can only occur in the latter. This ptomaine he considers to be a substance analogous in its effects to muscarine, acting on the vagus and especially on the gastric plexus, and on the cerebral cortex producing vomiting, narrowing of the pupil, etc. From the physiological antagonism between muscarine and atropine this latter drug would be indicated, and Lustgarten reports one case of recovery in which vomiting had already occurred, but which totally ceased after five milligrammes of atropine had been given subcutaneously. Locally drying and absorbent dressings are indicated, such as magnesia with an antiseptic in order to inhibit the development of the putrefactive process, and if no contra-indication exists, even the removal of the necrosed tissue by surgical means.

Reiss[2] contributes the results of his studies on this subject in an interesting article. He refers to the numerous observations lately made and the new theories put forward and reviews the principal ones. Regarding Welti's he says, "This theory will not stand the test for the reason that Welti only observed these changes a long time after the death of the animal experimented on, so that these changes were in all probability post mortem."

Reiss then continues, "None of these theories take into account the effect on the organism of substances created by the destruction of animal tissue at comparatively low temperatures and which creates toxæmia by their absorption.'' As it was impossible to obtain the blood of patients for examination as to the nature of these toxic substances (which would, he thinks, undoubtedly have given the best results), he undertook the examination of the urine. These investigations were carried out in five patients (four with fatal termination), all of whom had more or less anuria.

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[1] Wien. klin. Wochens., 1891; New York Medical Record, August 8, 1891.

[2] Archiv für Dermatologie und Syph., 1893; Ergänzungshefte I.

A subcutaneous injection of one cubic centimetre of normal urine in white mice caused no pathological symptoms whatever, but the same quantity of urine of one of these patients produced a soporific condition, soon passing into coma and followed in a few hours by clonic spasms of the trunk and extremities, and death. Repeated attempts always gave the same results, though sometimes death did not occur until the second day. In one mouse this fatal result occurred after only five divisions of a Pravaz syringe, showing that death was not produced by a heightened pressure in the system from the introduction of a large quantity of fluid.

Reiss next endeavored to ascertain whether this toxic substance was of nitrogenous or non-nitrogenous origin, and to this end studied the effect of various nitrogenous and non-nitrogenous substances. Fifteen grammes of cellulose were heated in a tube, the product mixed with a feeble salt and carbonate of soda solution, and then injected into an animal, but without any pathological result. Five grammes of serum albumen were then treated in the same manner, and after the injection of from three to five divisions of a Pravaz syringe, the same results were obtained as when the urine of patients suffering from burns was injected ; these results sometimes coming on after an interval of only a few minutes. The experiment was repeated on guinea-pigs with the same results, showing, therefore, that the toxic substances were nitrogenous.

The urine of these patients was then subjected to an analysis. The odor of this urine was a peculiar one and reminded of pyridine, and this odor was especially marked after adding a small quantity of liquor potassa and distilling. Three extracts, with alcohol, with water, and with ether were then made from this urine. Of these three the watery extract was moderately toxic, the ethereal only indifferently so, while the alcoholic showed itself to be the most poisonous of all; in mice death rapidly followed the injection of two to three divisions of the syringe, but upon heating and cooling this extract its toxic property rapidly decreased, showing that *the* toxic substance was volatile in character; this was also found to be the case with the nitrogenous serum albumen used as a control.

Believing that the toxic substance was an empyreumatic body belonging to the pyridine or chinolene group, he, by a complicated process, obtained from this alcoholic extract a clear fluid, which, when injected into animals, produced the same results as did the injections of the alcoholic extract and the serum albumen.

In order to study the chemical nature of this fluid better chloride of platinum was added to it, as this forms with pyridine a double salt. After evaporation in a vacuum, an orange-yellow, crystallizable body was obtained, which, dissolved in water, was without odor, but on the addition of liquor potassa gave forth the odor of pyridine. This salt had a melting point of 240° C., the same as the double salt of platinchlorid-pyridine. The Berlin blue test showed it to contain nitrogen.

Pyridine may be obtained by the dry distillation of organic nitrogenous substances. It is found in large quantity in the so-called bone oil (oleum animale, Dippel) and may also be obtained from coal-tar. Of late it has been produced synthetically. The most important representatives of these bases are pyridine (C_5H_5N), picoline (C_6H_7N), lepidine ($C_{10}H_9N$), lutidine (C_7H_9N), and parvoline ($C_9H_{13}N$). To these may also be added those insoluble in water, of the group of chinolene (C_2H_7N).

According to the experiments of Harnak and Meyer the action of this group on rabbits is an irritation of the convulsive centres in the spinal cord, resembling very much the action of nicotine. As other centres of the medulla—*i.e.*, the vagus—are not affected, it differentiates its action from that of picrotoxine. The pyridine bases have also an action on the motor centre of the cord and on the intermuscular nerve endings.

Reiss's observations with pyridine and also with this substance obtained from patient's urine, on animals, were identical and as follows: In all animals injected with the obtained substance there was observed a high degree of anuria; this could be produced in dogs by three to five divisions of a Pravaz syringe of the preparation, and by a syringe full of picoline; while guinea-pigs required only one and a half divisions of the syringe of picoline, or lutidine, to produce the same effect. The anuria lasted in dogs from twenty-four to thirty-six hours; in guinea-pigs much longer, especially after picoline. Further, in these latter, vomiting occurred, especially towards the end, when the injected material was producing its lethal effect. Somnolence followed by coma was also produced.

In white mice the injection of this obtained substance was followed by necrosis of the tissues around the point of injection, and this also occurred when the urine of patients was employed, but necrosis did not occur when normal urine was employed. In dogs, likewise, on the second day, a necrotic fistula followed the injection of patient's urine or of the obtained substance.

The phenomena following burns, especially such as have a fatal termination, are then the same as after poisoning with pyridine,—viz., somnolence, anuria, vomiting.

Reiss then raises the question if the cause of death following all burns is to be attributed to the formation of pyridine. In such cases where death is the result of a very high temperature, causing roasting of the tissue in contra-distinction to boiling, as from boiling water, the pyridine is probably produced by the high temperature. In the latter case he argues that the pyridine may and probably is produced at comparatively low temperature by synthesis.

Another observation was made at autopsies where examination of the internal organs usually failed to reveal any pathological changes, and that was, that the expressed juice of such organs as the liver, kidneys, and spleen had a peculiar empyreumatic odor, reminding, however, more of animal oil than of pyridine.

From these observations he draws the conclusions that the symptoms in fatal cases not due to shock or to some complication, as septicæmia, are probably produced by the action of pyridine or animal oil or some analogous substance, and this view is, he thinks, strengthened by the fact that as patients show symptoms of improvement the quantity of this empyreumatic substance becomes increased in the urine, showing that the kidneys are straining it off from the system ; while in those going on to a fatal termination the quantity in the urine remains small.

From these conclusions he would suggest the following therapeutic measures: As antagonizing or neutralizing substances to pyridine are unknown, measures adapted to free the system as quickly as possible should be employed. To this end venesection followed by infusion of salt solution and the ablation of the necrotic mass surgically to prevent absorption are indicated. These measures would have to be instituted early, before the advent of vomiting and somnolence, as Hebra's and Kaposi's vast experience have led them to make the statement that no case ever recovers after these symptoms have appeared.

In conclusion he states that he would not be understood as regarding all fatal cases as due to the action of these empyreumatic products, but only such as are not due to shock, sepsis, or other complication.

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